



How effective was England's teenage pregnancy strategy? A comparative analysis of high-income countries

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ABSTRACT

Teenage pregnancy is associated with numerous health risks, both to mothers and infants, and may contribute to entrenched social inequalities. In countries with high rates of teenage pregnancy there is disagreement on effective action to reduce rates. England's Teenage Pregnancy Strategy, which cost £280 million over its ten year implementation period, has been highlighted as an effective way of reducing pregnancies after rates fell by more than 50% from 1998 to 2014 and widely advocated as a replicable model for other countries. However, it is not clear whether the fall is attributable to the strategy or to background trends and other events. We aimed to evaluate the impact of the Teenage Pregnancy Strategy on pregnancy and birth rates using comparators.

We compared under-18 pregnancy rates in England with Scotland and Wales using interrupted time series methods. We compared under-18 birth rates and under-20 pregnancy rates in England with European and English-speaking high-income countries using synthetic control methods. In the controlled interrupted time series analyses, trends in rates of teenage pregnancy in England closely followed those in Scotland (0.08 fewer pregnancies per 1000 women per year in England; -0.74 to 0.59) and Wales (0.14 more pregnancies per 1000 women per year in England; -0.48 to 0.76). In synthetic control analyses, under-18 birth rates were very similar in England and the synthetic control. Under-20 pregnancy rates were marginally higher in England than control.

Although teenage pregnancies and births in England fell following implementation of the Teenage Pregnancy Strategy, comparisons with other countries suggest the strategy had little, if any, effect on pregnancy rates. This raises doubts about whether the strategy should be used as a model for future public health interventions in countries aiming to reduce teenage pregnancy.

1. Introduction

Teenage pregnancy is associated with numerous health risks, both to mothers and infants. Teenage pregnancies are more likely to be unintentional than are adult pregnancies (Wellings et al., 2013). Such pregnancies are also at greater risk of health problems, including maternal anaemia, pre-eclampsia, infant mortality, pre-term labour, and longer and more difficult labour (Irvine et al., 1997; Social Exclusion Unit, 1999). Complications arising from pregnancy and childbirth are a leading cause of death amongst adolescents worldwide (World Health Organization, 2020). Teenage mothers are also at greater risk than their peers of poor mental health, suicide, and substance use problems (Hodgkinson et al., 2014).

Early pregnancy is more common among women from poorer families, single-parent households, areas of greater deprivation, and those born to teenage parents (Information Services Division Scotland, 2018a;

Irvine et al., 1997; Social Exclusion Unit, 1999). Teenagers with a previous pregnancy are up to five times more likely to experience rapid repeat pregnancies (Falk et al., 2006). Teenage parents are more likely to face barriers to further education, employment or training, and may require greater social support for parent and child health and positive family relationships, and income and housing support (Bradley et al., 2002; Letourneau et al., 2004; World Health Organization, 2020). Advocates of teenage pregnancy prevention as a public health priority propose that reduction in rates could improve maternal and child health and reduce health and social inequalities (Social Exclusion Unit, 1999; World Health Organization, 2020).

Globally, though pregnancy rates have reduced in several European countries, low-income countries continue to show higher rates (Sedgh et al., 2015; World Health Organization, 2020). Amongst high-income countries, several English-speaking countries have seen relatively high rates of teenage pregnancy in recent decades, prompting policy action

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(Paton et al., 2020). Interventions of several kinds have been implemented, with varying evidence of effectiveness (Swann et al., 2003; Trivedi et al., 2007). Following a review of previous international approaches to develop an effective intervention, the Teenage Pregnancy Strategy was introduced in England in 1999, aiming to reduce under-18 pregnancy rates by 50% in ten years, whilst providing support to teenage mothers (Hadley et al., 2016b; Social Exclusion Unit, 1999).

The Strategy took a multifaceted approach to reducing rates of teenage pregnancy and addressing associated health and social problems. This involved: structured and ‘joined up’ action at national and local level to ensure coordinated, equal effectiveness in all areas; improvements in pregnancy prevention resources for schools and local authorities, including contraception access, education and media-campaigns to teenagers and parents; and greater support for young parents to remain in education and access housing and other health support (Hadley et al., 2016a; Social Exclusion Unit, 1999). A mid-term review in 2005 led to significant changes in implementation, including publication of new guidance for local authorities, a redesigned media campaign, new health and education programmes, and increasing access to contraception (Hadley et al., 2016b). The Strategy was claimed by its development and evaluation teams to be the first of its kind, coordinating local and national action to reduce pregnancies nationwide (Social Exclusion Unit, 1999; Teenage Pregnancy Strategy Evaluation, 2005).

£60 m of funding was allocated for the first three years of the strategy (including £12 m allocated to specific projects for young parents’ housing and childcare; Social Exclusion Unit, 1999). Expenditure on the Strategy from central government, local authorities, health authorities, other government programmes and charities, came to £167.6 m by the mid-term review in 2005 (Teenage Pregnancy Strategy Evaluation, 2005) and reached an estimated £280 m by the end of strategy activity in 2010 (Billingsley, 2011).

The strategy was deemed a success following observations of declining pregnancy rates (Hadley et al., 2016a, 2016b; Ma, 2016; Skinner and Marino, 2016; Wilkinson et al., 2006). Evaluations conducted before the end of the strategy term observed small decreases in rates in England relative to pre-1998 baseline rates, but little difference from Scotland and Wales’ changes (Wilkinson et al., 2006). A later analysis noted a fall in rates of teenage pregnancy across the period of implementation, from 47.1 pregnancies per 1000 women aged under 18, to 22.9 per 1000 women by 2014 – a drop of 51% (Hadley et al., 2016b; Wellings et al., 2016). This was compared with a mean reduction of 22% in under-18 births across 28 European comparison countries (Wellings et al., 2016). The study concluded that the Strategy, “alongside other social and educational changes, has probably contributed to a substantial and accelerating decline in [under-18] conceptions” (Wellings et al., 2016, Abstract). Both studies observed greater decreases in rates in areas with greater strategy-related spending (Wellings et al., 2016; Wilkinson et al., 2006).

The strategy has been promoted as a unique, national approach, whose substantial cost was justified by the observed fall in pregnancies (Hadley et al., 2016b; Skinner and Marino, 2016). It has been held up as a replicable model for implementation in countries with similarly high rates and for ongoing government action in the UK (Hadley et al., 2016b; Public Health England and Local Government Association, 2018; UNESCO Education Sector, 2017). Despite this, the strategy has drawn criticism in several areas of its design and evaluation.

Several authors have questioned whether framing teenage pregnancy prevention as a public health priority is justified (Arai, 2009; Lawlor et al., 2001; Lawlor and Shaw, 2002). It is uncertain how much becoming pregnant as a teenager contributes to these poor outcomes, or whether other socioeconomic factors may be the cause of both (Hoffman, 1998). Other action to tackle the societal structures perpetuating these inequalities may have greater effect (Lawlor et al., 2001).

Queries have also been raised as to whether the focus of the Teenage Pregnancy Strategy was appropriate (Arai, 2009). In the report setting

out the strategy, the Social Exclusion Unit (1999) identifies three targets: ‘low expectations’, ‘ignorance’ and ‘mixed messages’ (Social Exclusion Unit, 1999, p. 7). Ultimately, however, the strategy appears to have considered ‘ignorance’ to be the most influential contributor to high rates of pregnancy, presenting it as the easiest, most feasible, most economical and most acceptable to remedy (Arai, 2009; Carabine, 2007). This reflects a view that teen pregnancy is “an educational or medical problem to be solved by increased access to contraception, abortion, and sex education” (Geronimus, 1997, p. 408). This assumption was manifested in the strategy’s emphasis on information and education alongside provision of contraception.

Recent reviews have queried the effectiveness of these approaches (Andrzejewski et al., 2018; Marseille et al., 2018), and later studies have queried whether England’s decrease in teenage pregnancy rates is due to the strategy. Craig et al. (2016a) note that pregnancy rates followed a similar pattern in other UK countries. Paton et al. (2020) show that across several countries, teenage pregnancy prevention policies with components similar to the strategy do not explain the observed drops in pregnancy rates. Cuts in spending in areas of England, effectively halting strategy-related activity, did not lead to an increase in pregnancy rates in an expected dose-response relationship (Paton and Wright, 2017). A recent study that shows continued decreases in rates beyond the ending of the strategy further calls in question whether the earlier fall was attributable to the strategy (Heap et al., 2020).

To further examine the strategy’s contribution to reducing rates of teenage pregnancy, we apply natural experiment methods to data from other high-income countries. The substantial cost of the teenage pregnancy strategy, and its promotion as a model for other countries, mean that reliable estimates of its impact are important for future policy making. We tested the effectiveness of the teenage pregnancy strategy in two ways. In our first analysis, we chose Scotland and Wales as comparators given their similarity to England in other factors which may affect teenage pregnancy rates. We used interrupted time series methods to compare each country with England across the implementation period and up to most recent observations. To account for potential contamination among neighbouring UK countries, in our second analysis we compared birth and pregnancy rates in England with those of a wider pool of potential control countries using synthetic control methods.

2. Methods

2.1. Data collection

In each analysis, we set the intervention start as 1999. For the interrupted time series analyses, we extracted rates of teenage pregnancy directly from the Office for National Statistics (ONS) report for England and Wales (Office for National Statistics, 2019) and Information Services Division (ISD) report for Scotland (Information Services Division Scotland, 2018a) for all reported age groups (under-16, under-18 and under-20). Both sources used the same calculation, summing recorded births, still births and abortions in each age group, correcting for date of conception and for multiple births, and dividing by the estimated age group female population (Information Services Division Scotland, 2018a; Office for National Statistics, 2017). Scottish rates were only reported for 1994 onwards, so to supplement these we used records of Scottish births (National Records of Scotland, 2018), abortions (Information Services Division Scotland, 2018b), and estimates of population (University of California and Max Plank Institute of Demographic Research, 2019) by age to estimate Scottish under-18 pregnancy rates from 1987 to 1993 to match the earliest data available for England and Wales. We did not include Northern Ireland due to the unreliability of estimates of abortions (Family Planning Association, 2015).

We considered pregnancy to women aged under-18 as a target outcome, as specified as a strategy goal (Social Exclusion Unit, 1999, p. 8), using comparisons with England-only data as a primary analysis.

In secondary analyses, to test using other age groups and for longer pre-intervention periods, we used England and Wales combined data as England-only data was not available. Aggregated England and Wales rates were compared with Scotland to test for effects on under-16 and under-20 pregnancies from 1992 to 2016 as secondary populations, and under-18s from 1987 as a secondary measure over a longer time-period. We compared England only data with England and Wales combined data for years recording both to assess the suitability of the combined data as a proxy for exposed England. England contributed around 95% to both population and pregnancy outcomes and rates were very similar across all years, suggesting that aggregated England and Wales rates were a good indicator in the absence of England-only data.

For the synthetic control analyses, we selected countries for comparison based on cultural, political, geographical and economic similarity to England. We sought data on teenage births and pregnancies for all Euro-peristat nations (Euro-Peristat, 2018) and other high-income Anglophone countries. We aimed to collect data recording births and pregnancies for at least eight time points before and after the intervention.

We used data estimating births by age of mother from the Human Fertility Database (Max Planck Institute for Demographic Research, 2019), populations from the Human Mortality Database (University of California and Max Planck Institute of Demographic Research, 2019), and numbers of abortions to women under-20 from the WHO Health for All Explorer (WHO Regional Office for Europe, 2019). Data on births, abortions and pregnancies for countries not included in the Human Fertility Database were sought from national statistics websites. Pregnancy and birth rates for the USA were extracted from the Guttmacher Institute report. These were calculated using population, birth and abortion data from the National Centre for Health Statistics and the Center for Disease Control (Kost et al., 2017). Pregnancy and birth rates for New Zealand were calculated from Statistics New Zealand reports on births and abortions, combined with Human Mortality Database population estimates (Statistics New Zealand, 2019a, 2019b). Full details are given in Supplementary File Section A.

Four countries were excluded for which no data or incomplete data were available (Austria, Australia, Ireland, and Canada). This was due to different age groupings, insufficient time points or no reliable records of abortions. Finally, we excluded eight European countries that were either in Yugoslavia or the USSR, or were USSR-backed, as they had turbulent histories around this time making them less useful as comparators (Hungary, Estonia, Lithuania, Slovenia, Czechia, Poland, Croatia, and Bulgaria). The final selection of fifteen control countries is shown in Table 1.

Outcome rates for 1990–2013 were calculated as the earliest and latest dates with data available for a sufficient set of comparison countries. We calculated under-18 birth rates by summing all births to women aged under-18 and dividing by total populations aged 15–17, matching the age group reported by ONS and ISD Scotland (Information Services Division Scotland, 2018a; Office for National Statistics, 2017). We used births only as we did not find reliable data estimating abortions to under-18s for all countries, and so we could not estimate total pregnancies. We calculated under-20 pregnancy rates by summing all under-20 births, adding total abortions to women under 20 and dividing by total populations aged 15–19. Data did not allow correction for

multiple births or date of conception (as used by ONS and ISD Scotland to calculate reported rates above), and so both measures used in SC analyses are proxies of true pregnancy rates. We recalculated England and Wales' and Scotland's under-18 birth-rates from these datasets to make them comparable. England and Wales were used as a single unit as only combined data were available.

Estimates of yearly gross domestic product (GDP), mobile phone ownership, proportion of females in population and proportion of population resident in urban settings for years 1990–2013 were extracted from World Bank open data as predictor variables for the synthetic control models (The World Bank Group, 2019). Public spending on education as a proportion of GDP for the years 1990–2013 was extracted from OECD data (Organisation for Economic Co-operation and Development, 2018).

2.2. Statistical analysis

All analyses used R (R Core Team, 2020) and RStudio (RStudio Team, 2015). We built a Shiny app to carry out the ITS analysis (Chang et al., 2019). All R packages used are listed in Supplementary File Section A.

To compare England with Scotland and Wales we used interrupted time series methods (Craig et al., 2017; Kontopantelis et al., 2015; Lopez Bernal et al., 2018). In our preparatory models we fitted a trend line to England observations before the start of the strategy in 1999 to estimate the baseline trend as an hypothesis of the trajectory England would have followed in the absence of the strategy.

We then fitted an intervention trend line to data from 1999 to 2016 to estimate the changes in trend and level from the start of the strategy. This allowed years beyond the 2010 end of the intervention to contribute to estimates of its effects, consistent with previous evaluations. We visually inspected the pregnancy rates across this period to determine if any changes immediately after the 2010 end indicated a temporary effect of the strategy, requiring exclusion of later data. This trend remained consistent and so these time points were used in all analyses as assumed ongoing effects of the strategy.

Our comparison models used Scotland and Wales as control populations to estimate the expected changes at 1999 in the absence of the strategy. Changes in level and trend seen in Scotland and Wales were subtracted from those seen in England to give estimates of the strategy's effects, corrected for background changes common to all three countries.

To improve the fit of the pre-intervention rates, we added a 'pill scare' dummy variable across all three countries for all dates from 1996 onwards. This aimed to account for the hypothesised effects of a warning issued concerning the safety of oral contraceptive pills in 1995 and the subsequent fall in contraceptive use (Furedi, 1999; Teenage Pregnancy Strategy Evaluation, 2005; Wellings et al., 2016).

Inspection of pre-intervention trends between England and controls indicated that all three countries closely followed the same pattern before the strategy. Therefore, the primary model used the assumption of pre-intervention parallel trends, allowing more stable predictions from the limited pre-intervention data. After examining rates across all three countries, we saw a similar trend change occurring from 2008 onwards, dividing the post-intervention period into two segments. In sensitivity analyses we treated 2008 as a common shock across all countries and allowed a common trend change to better fit the observations. To test whether allowing for a phase-in period improved model fit, we excluded data for the years immediately following the start of the intervention. This made no difference to fit or prediction, so all data were retained in final analyses.

Data for England alone was only available for 1992 onwards, giving seven pre-intervention time points. To test model sensitivity by examining longer pre-intervention time periods, we used combined England and Wales data, available from 1987, to compare with Scotland.

We tested for autocorrelation using Durbin-Watson tests, and autocorrelation and partial-autocorrelation function plots. We applied

Table 1
Countries selected to construct synthetic controls.

Denmark	Norway
Finland	Portugal
France	Scotland
Germany	Spain
Iceland	Sweden
Italy	Switzerland
Netherlands	USA
New Zealand	

corrections to our final models when autocorrelation was evident across all three tests. Finally, we extracted coefficients and 95% confidence intervals for difference in level and trend change seen in England over controls at each time period and used these as markers of change due to intervention.

In our second analysis, we used synthetic control methods to construct a comparison unit from a weighted average of other countries' rates, fitted to pre-intervention England and Wales observations. We used under-18 birth rates as a primary outcome and under-20 pregnancy rates as a secondary measure to get a clearer estimate of effect on pregnancies rather than births. Initial models used each country's mean rate across the whole pre-intervention period (1990–1998) as a single predictor to construct the synthetic England. To improve the pre-intervention control fit, we used a data-driven approach by finding optimal groupings of years and calculating means for each period as a predictor, to account for the non-linear pattern of the yearly rate changes. The optimal grouping was chosen as a combination of as few groups as possible and a minimised mean squared prediction error. After selecting the best pre-intervention fit rate-only model, we tested the effects of adding other predictors on the overall model fit.

To test our models, we conducted several robustness checks and sensitivity analyses. Removing England and Wales data, we repeated the synthetic control analyses for each of the other countries as placebos and recorded observed and predicted values. Yearly differences between observations for England and Wales and their synthetic control were plotted alongside corresponding differences calculated for the other countries and their synthetic controls to check whether England and Wales was a comparative outlier. We excluded countries with greater than 5-times the pre-intervention MSPE of England and Wales for to compare the exposed population with similarly well fit placebos. Using all comparison countries, we calculated post/pre-MSPE ratios for each country and examined their distribution to check whether England and Wales saw a large deviation from predicted post-intervention rates compared to unexposed countries. Finally, we constructed plots of observed and synthetic rates for models fitted to dummy intervention dates across 1995–1998 to examine whether the model was robust to shocks in pre-intervention years.

We performed sensitivity analyses to test the reliability of our models. We re-ran models with countries removed from the donor list to test for over-reliance on a few countries' data. We iteratively removed the top-weighted country in each analysis, plotting yearly differences between England and Wales and the new synthetic control, and extracting pre-intervention MSPE for each to test whether results remained consistent as donor countries were removed.

3. Results

3.1. Comparing England with Scotland and Wales using interrupted time series methods

England saw a 60% drop in under-18 pregnancies between 1998 and 2016, from 46.6 to 18.8 pregnancies per 1000 women (Fig. 1). Across the same period, Scotland saw a reduction in pregnancies of 58% (from 44.7 to 18.9 pregnancies per 1000 women) and Wales of 62% (from 55.0 to 20.9 pregnancies per 1000 women). All three countries saw a small jump in rates in 1996, consistent with hypothesised effects of the 1995 'pill scare' leading to less contraceptive use (Furedi, 1999).

Fig. 2a from an interrupted time series (ITS) analysis using England-only before and after comparison shows an initial upward trend of 0.70 more pregnancies per year per 1000 women (95%CI: -0.34 to 1.74) during the pre-intervention period that is reversed by a clear change in trend from 1999 onwards, with an accumulating 2.22 fewer pregnancies per 1000 women per year than predicted from pre-strategy rates (95% CI: -3.49 to -0.95). Addition of a pre-intervention change in level that accounts for the 'pill-scare' in 1996 improved model fit for the pre-intervention period (Fig. 2b). The corrected pre-intervention trend

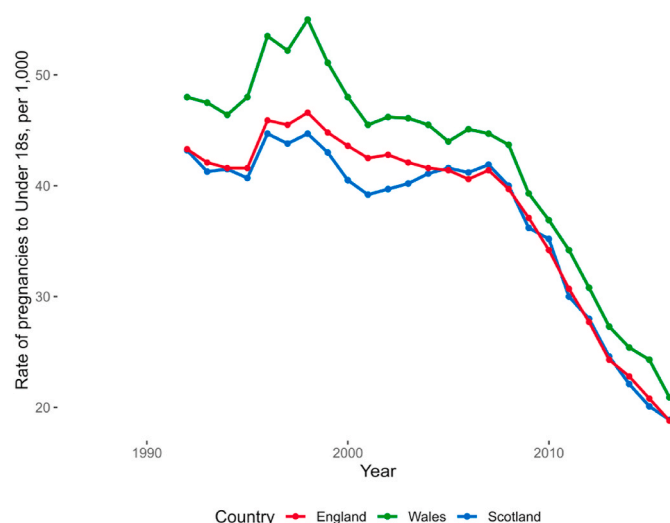


Fig. 1. Under-18 pregnancy rates across England, Wales and Scotland 1992–2016.

was -0.11 per year (95%CI: -1.10 to 0.88), with a reduction in trend from 1999 onwards of an additional accumulating 1.41 fewer pregnancies per 1000 women per year than predicted (95%CI: -0.24 to -2.58 ; Fig. 2b). The 1996 corrector was used in further analyses. No statistically significant level changes were observed at 1999.

In the controlled ITS analyses, these effect sizes were greatly decreased. Level and trend changes in Scotland and Wales data were applied to England's pre-intervention trend to predict a 'No Strategy' control, assuming that the observed changes in control countries would have occurred in England without the TPS. In comparison with a control constructed from Scotland's level and trend changes, there was a decrease of 0.08 pregnancies per 1000 women per year in England (95% CI: -0.74 to 0.59 ; Fig. 3a). In comparison with Wales, England saw a small increase over control of 0.14 pregnancies per 1000 women per year (95%CI: -0.48 to 0.76 ; Fig. 3b). All controlled models showed results consistent with a null effect of the Teenage Pregnancy Strategy.

In a further set of analyses (Supplementary File Section B), we allowed for a 'common shock' at 2008 to account for a common change in trend in all three countries from 2008 onwards. This may represent an unknown UK-wide or global confounding event. These also revealed no statistically significant differences between England and controls. Finally, we combined England and Wales data to examine longer pre-intervention periods as well as under-16 and under-20 pregnancy rates. No statistically significant differences were seen at 1999 across these analyses. Removal of datapoints immediately following 1999 to account for a phase-in period did not improve fit.

3.2. Comparing England and Wales with other countries using synthetic control methods

Our primary synthetic control model used under-18 birth rates from 15 countries and calculated means of four groupings of pre-intervention years as predictors (1990–1993, 1994, 1995, 1996–1998). We were able to construct good-fit synthetic controls to compare with England and Wales using only pre-intervention birth rates. The prediction error of this model was 0.30 births per 1000 women per year around a mean of 16.2 births per 1000 women across 9 years (Mean Squared Prediction Error, MSPE: 0.09; Fig. 4a). This model was used as our primary comparison. The synthetic control for England and Wales was constructed from a weighted mean of Scotland (weighted 67.2%), Portugal (29.5%), the U.S.A. (1.6%) and New Zealand (1.2%). Birth rates for the synthetic control closely followed the observed birth rates in England and Wales across the whole post-intervention period. While England and Wales saw

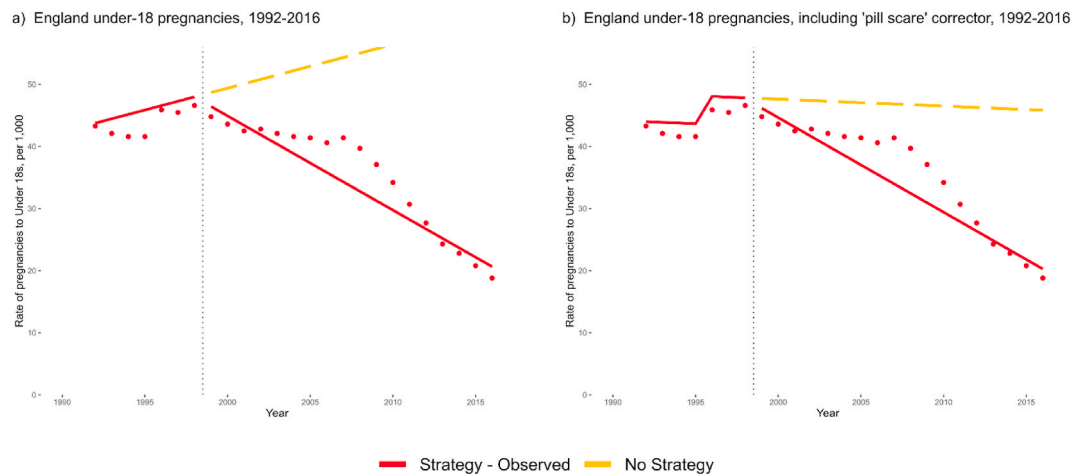


Fig. 2. Uncontrolled interrupted time series comparisons of England's before and after under-18 pregnancy rates. In the initial comparison without corrector in a), England saw a level change of -0.03 (-3.08 to 3.01) at 1999 and a trend change of -2.22 (-3.49 to -0.95). With the addition of a corrector at 1996 in figure b), the level change became -1.14 (-2.62 to 2.34) and the trend change -1.42 (-2.58 to -0.24). All models are corrected for autoregression at lag 1.

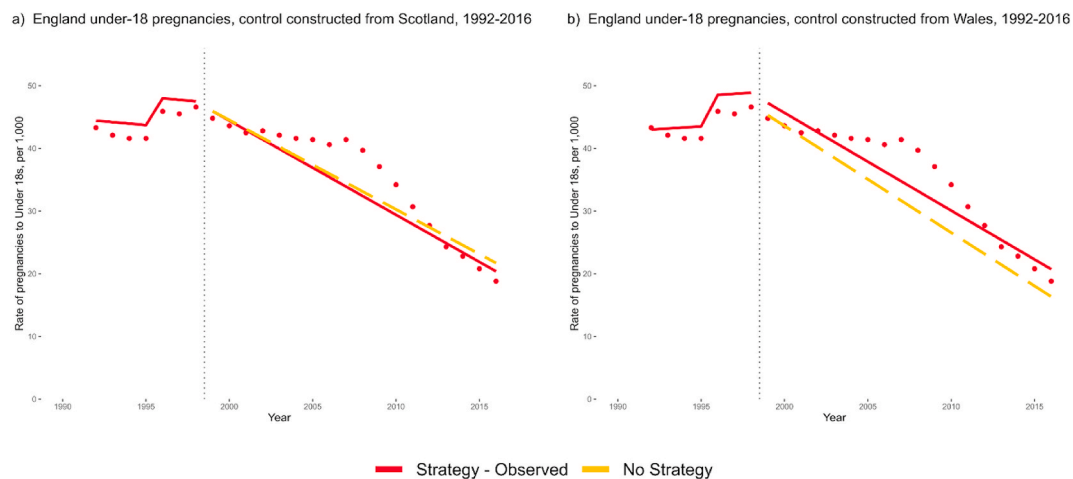


Fig. 3. Controlled interrupted time series comparisons, using data from Scotland and Wales to predict England's changes in rates without the TPS. In comparison to control adjusted to match Scotland's change in level and trend at 1999, England saw a level change of 0.06 (-4.03 to 4.16) and a trend change of -0.08 (-0.74 to 0.59 ; graph a). In comparison to control adjusted using Wales' data, England saw a level change of 1.81 (-2.30 to 5.91) and a trend change of 0.14 (-0.48 to 0.76 ; graph b). All models are corrected for autoregression at lag 1.

a drop in birth rates of 53% between 1998 and 2013, the control saw a 50% drop.

Gaps between the observed rates for each country and the predicted rate for its synthetic control are plotted in Fig. 4b. Post-intervention effect sizes for England and Wales fall within the range of gaps for other countries with a well-fitting synthetic control. The post/pre-MSPE ratio for England and Wales, measuring comparative variance between fitting and predicting periods, was calculated as 1.86. 13 of the 16 control countries saw a larger post/pre-MSPE ratio, indicating that the probability of observing a ratio at least this large in the absence of an effect is $p = 0.88$. These results are consistent with a null effect of the TPS.

Using under-20 pregnancies as a secondary outcome resulted in a slightly poorer pre-intervention fit, with a pre-intervention average prediction error of 2.07 pregnancies per year around a mean of 62.3 pregnancies per 1000 women (MSPE: 4.27; Fig. 4c). Poorest fit was seen across the years 1996–1998, immediately preceding the strategy and correlated with the pill-scare jump occurring predominantly in the UK. The control saw a slightly greater decrease in pregnancy rates than England and Wales during the strategy period, but a relatively small post/pre-MSPE ratio compared to placebo countries (9.1; rank 11 out of

16 countries; $p = 0.69$; see Supplementary File Section C). Gaps were within the range produced by noise in other country comparisons with controls (Fig. 4d). Our time-placebo analyses tested the model with dummy interventions across 1995–1998. When set at 1995 and 1996, the predicted control rates were much lower than England and Wales, but 1997 and 1998 produced controlled models very similar to the true model. These results are consistent with a null effect of the strategy.

All sensitivity tests are reported in Supplementary File Sections C and D. When we removed Scotland from the donor pool, we saw poorer pre-intervention fit and a small drop in under-18 birth rates in England and Wales compared to control throughout the strategy-period. This difference from control was still relatively small compared to the noise seen in placebo countries and gave no strong indication of an intervention effect. Optimising model-fit to the immediate pre-intervention years 1996–1998 to account for the 'pill scare' did not produce an effect. Across all other analyses, we saw poorer predictor fit than our primary and secondary models, and consistent, small gaps between England and Wales and control, with higher birth and pregnancy rates in England and Wales across the intervention period. This is consistent with a null effect of the strategy.

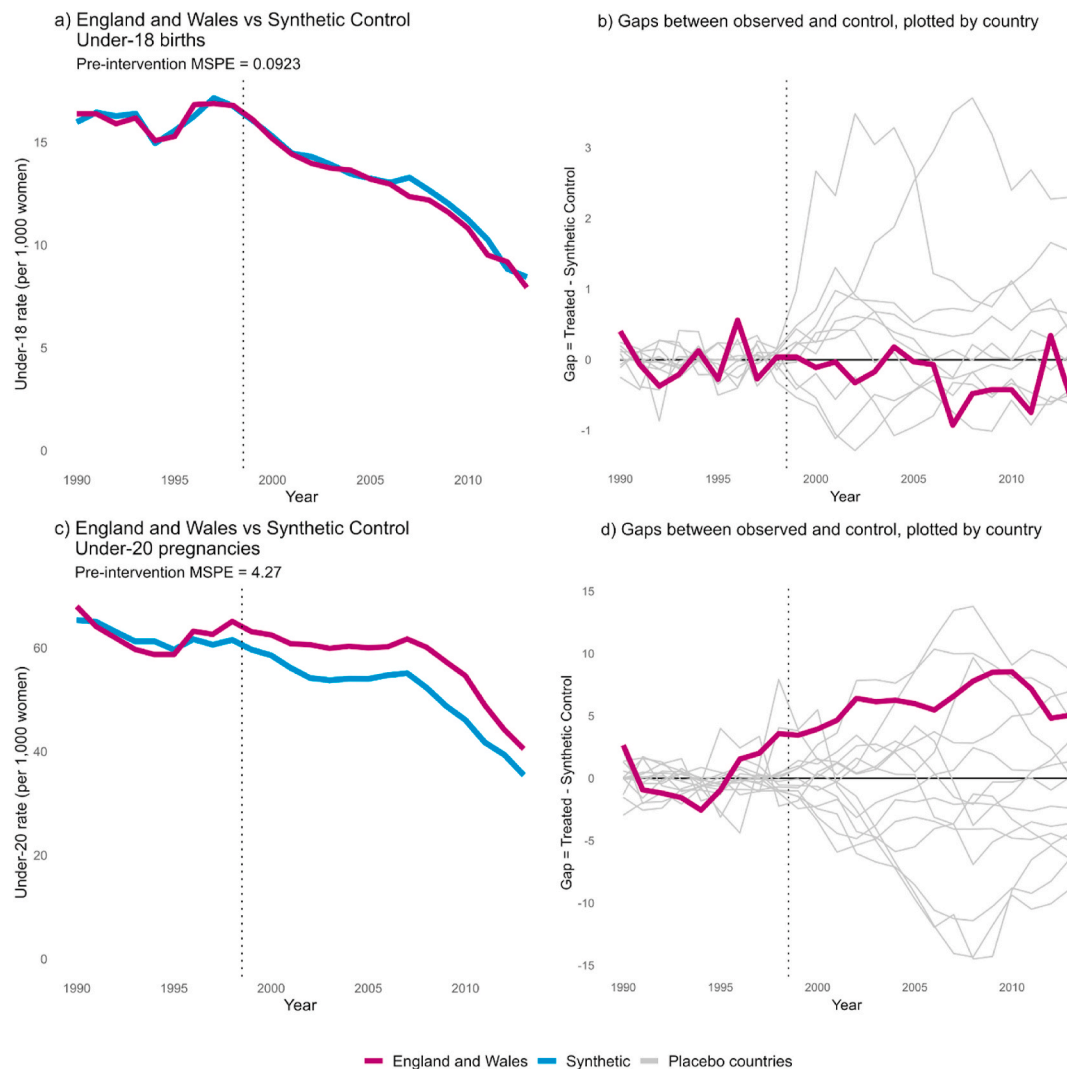


Fig. 4. England and Wales' observed combined under-18 birth rates compared with synthetic control, 1990–2013. In graph a, rates are plotted for pre- and post-intervention periods, with a pre-intervention fit (Mean Squared Prediction Error; MSPE) of 0.09. In graph b, yearly differences between England and Wales and its synthetic control are plotted alongside similarly calculated gaps for ten placebo countries, with pre-intervention fits close to England and Wales (less than 5 times England and Wales' pre-intervention MSPE). Graphs c and d plot under-20 pregnancy rates across the same period alongside predicted control (MSPE = 4.27) and yearly differences compared across countries.

4. Discussion

4.1. Main findings

We find no evidence of an effect of the Teenage Pregnancy Strategy on rates of teenage pregnancies or births in England between 1999 and 2016. Analysis of England-only data showed a clear change in trend during the Strategy period, consistent with previous observations (Wellings et al., 2016). However, the similar changes observed in other UK, European and English-speaking countries suggest that England may have seen a similar fall in teenage pregnancy in the absence of the Strategy. This finding of little, if any, impact was consistent across two methods using different datasets, and was robust to sensitivity analyses.

4.2. Strengths and limitations

We used publicly available, reliable data from several sources which was comparable across countries. Whilst natural experiment methods each have weaknesses which threaten the confidence of causal inference (Craig et al., 2017), our use of two methods and several comparisons sought to account for these. The coherence of conclusions reached

through all analyses strengthens our findings.

In ITS models, data were limited in terms of periods of observation for each age group. Under-18 pregnancy rates for England alone represented our primary outcome; however, in published data, these were only available for seven pre-intervention time points (Office for National Statistics, 2019). A minimum of eight time points for ITS analyses are usually recommended; our primary models may have lacked power to detect small changes (Lopez Bernal et al., 2017; Penfold and Zhang, 2013; Zhang et al., 2011). Sensitivity analyses using England and Wales data with more pre-intervention time points were used to account for this and achieved consistent results.

The outcome measures for each analysis had several limitations. Rates calculated for the UK using the ONS methods of adding births, still births and recorded abortions are not able to account for miscarriages and illegal abortions (Office for National Statistics, 2017). As all three countries had similar laws, healthcare and access to abortion clinics, we judged that these errors would be unlikely to have been differentially distributed across countries and therefore would produce negligible bias in comparative analyses. In comparisons with countries outside of the UK, we used counts of births and sums of births and abortions to estimate pregnancies. These data were not able to be corrected in the same

manner as ONS and ISD Scotland data, and so are less reliable measures of actual pregnancy rates. However, they provided estimates of births and pregnancies to teenage mothers using consistent definitions and data sources, which were comparable across countries.

In SC analyses, under-18 pregnancy rates were not directly calculable as under-18 abortion estimates were not reliably available in a consistent way across all countries. The two measures, under-18 births in our primary analyses and under-20 pregnancies in sensitivity analyses, were used in place of under-18 pregnancies and gave consistent results. Other cultural and environmental changes which are hypothesised to be causative of changing teenage pregnancy rates, such as unemployment and years of schooling and further education, were not able to be controlled for in the SC analyses. In several cases consistent data was not available for all comparator countries. Measures of females in higher education was an unsuitable control as it combines both cause and effect of pregnancy rates. Our analyses assume that England is similar to comparators in these measures.

In our SC sensitivity tests, pre-intervention fit was poorest across the period 1996–1998, particularly after removal of Scotland. This increase in rates, observed mainly in UK countries (and across all measures used) has been attributed to media messages surrounding suggested health risks of certain contraceptive pills around 1995 – the ‘pill scare’ (Social Exclusion Unit, 1999; Teenage Pregnancy Strategy Evaluation, 2005). The event was confined to the UK and was followed by reductions in oral contraceptive use (Furedi, 1999). This may have contributed to the higher rates of pregnancy than control across the whole period from 1995 to 2013 and may explain the time-placebo test results showing large differences from 1995 to 1996 dummy intervention dates. However, when we accounted for this by optimising the pre-intervention fit to the years 1996–1998 alone, we still saw no difference from control that would be consistent with an effect of the Strategy.

Concerns have been raised about using Scotland and Wales as comparators to identify the effects of the English strategy, either because they may have been contaminated by the media campaign (Craig et al., 2016a, 2016b), or because they implemented similar policies (Teenage Pregnancy Strategy Evaluation, 2005; Wellings et al., 2016; Wilkinson et al., 2006). Contamination is a possibility, but any spill over effects should be weaker than the effect of direct exposure to the strategy. Our analyses would have been able to detect any additional effect in England associated with full exposure to the strategy, consistent with an expected dose-response effect of more intense action and focus on England. An alternative hypothesis is that the strategy’s media campaign was predominantly responsible for the very similar observed changes across England, Wales and Scotland, and that other elements of the Strategy had little or no effect. However, Wellings et al. (2016) report differential effects associated with strategy spending between local authorities in England. Such effects should also be evident in cross-border differences yet the trends in England, Scotland and Wales are all very similar. Contamination and spill over effects should not affect the validity of the synthetic control analyses.

Other interventions implemented across this period in comparator countries may have impacted effect estimates (Cherry and Dillon, 2014); our models do not explicitly correct for these. Amongst highly weighted countries, similar whole-population approaches were known of in two cases. The USA saw the launch of a strategy in 1996 (Foster, 1997) and Scotland saw a report in 2003 on Enhancing Sexual Wellbeing, leading to the Respect and Responsibility strategy launch in 2005 (Scottish Executive, 2003, 2005). The USA-based strategy, however, was not a similarly nationally funded and coordinated action, and the Scotland strategy did not exclusively target teenage prevention. The wide gaps in timings of implementation of each of these from the strategy itself, additionally, limit their ability to account for the 1999 change in trend in synthetic control, matching exposed England. Evaluations of other teenage pregnancy interventions implemented in Scotland do not suggest effects that could mask a substantial effect of the English strategy in ITS analyses (Henderson et al., 2007; NHS Health Scotland, 2014).

Our analyses group divergent, smaller scale and asynchronous approaches in other countries as a heterogeneous treatment-as-usual, to compare with the claimed uniqueness of the Teenage Pregnancy Strategy. Ongoing, sustained policy across all countries may have produced a common effect, not sensitive to these differences. However, there is little evidence of the additional effectiveness of the strategy’s holistic approach and increased spending.

Our analysis only examines the effects of the strategy on its first aim of reducing pregnancy rates. The provision of services supporting young mothers after conception was an additional strategy aim, not addressed here (Social Exclusion Unit, 1999). As Lawlor et al. (2001) argue, such aims may have positive effects on the health and social inequalities associated with teenage parenthood. The strategy may have been effective for these outcomes (Wellings et al., 2016). However, reduction of pregnancy rates is highlighted as a key part of the strategy and observations of falling rates are cited as evidence of its effectiveness in previous evaluations (Hadley et al., 2016b).

4.3. Implications

Our results conflict with previous conclusions from observations of population-level changes in England’s rates and region-level associations between strategy spending and lowered pregnancy rates (Wellings et al., 2016; Wilkinson et al., 2006) but are consistent with the findings of several other studies suggesting little or no strategy effectiveness (Blackman, 2013; Heap et al., 2020; Paton et al., 2020; Paton and Wright, 2017). Similarities between England and comparators suggest that the observed drop in England’s rates was mostly attributable to causes spanning several countries. The association between regional strategy spending and falling rates may be due to endogeneity as high base rates both drove allocation of funding and were associated with greater change (Heap et al., 2020; Wilkinson et al., 2006).

Despite the large drops after 1999, teenage pregnancy and birth rates in England remain comparatively high amongst the countries considered here. These rates remain a target of public health intervention, and current policy cites the strategy as a model (Public Health England and Local Government Association, 2018). Our findings suggest the Teenage Pregnancy Strategy should not be relied upon as a means of further reducing pregnancy rates in England, or as a replicable model for other countries with high pregnancy rates. Some aspects of the strategy, however, may have had positive impacts on the health and wellbeing of young mothers – valuable effects which we do not address here (Wellings et al., 2016).

It is not yet clear what produced the observed changes. Further research could test other hypothesised causes behind the observed rates across several countries during the time-period. Other potential causes have been suggested, such as economic changes, improvements in contraception technologies, changes in other social welfare policies and greater access of young women to education (Girma and Paton, 2015; Heap et al., 2020; Kearney and Levine, 2015; Sipsma et al., 2017). A recent study modelling several of these hypothesised causes found positive effects of growing ethnic diversity, reduced unemployment, educational attainment and access to housing, but concluded that there was still unexplained effects from other factors not considered (Heap et al., 2020). There are also suggestions that expanding broadband access and introduction of smartphones from 2007 onwards may have contributed to global trends in decreasing adolescent sexual activity alongside other risk behaviours (Guldi and Herbst, 2017; NHS Digital, 2019; Twenge, 2017). This is consistent with the observed common change in pregnancy trends at 2008 across England, Wales and Scotland (Supplementary File Section B). These changes are likely to have influenced rates across several countries. These causes may inform future research and policy development by highlighting new modifiable causes or opportunities for effective intervention.

5. Conclusions

We found no evidence of any impact of the Teenage Pregnancy Strategy on rates of pregnancy or birth among adolescents in England. Our analyses suggest that the same pattern of decreasing rates would have occurred without the strategy. The strategy should not be used as a model for future public health interventions in England or in other countries.

Credit attribution

Andrew Baxter: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration, Ruth Dundas: Conceptualization, Writing – review & editing, Supervision, Funding acquisition, Frank Popham: Conceptualization, Writing – review & editing, Supervision, Funding acquisition, Peter Craig: Conceptualization, Writing – review & editing, Supervision, Funding acquisition

Ethical approval

Ethical approval was not required.

Code and data for reproducibility

Interrupted time series analyses were conducted using a purpose-built Shiny app in R. These can be re-run without prior R knowledge at andybaxter.shinyapps.io/teen_preg_uk_its. All code used for data cleaning and analysis is available online at github.com/andrewbaxter439/teen-preg-project (archived at <https://dx.doi.org/10.5281/zenodo.3822193>) and github.com/andrewbaxter439/TTS_shinyapp (archived at <https://dx.doi.org/10.5281/zenodo.3822198>). Data sets of calculated outcomes and predictors for countries are included; raw data used to calculate these is available from respective websites, detailed above.

Protocol

The protocol for the analysis was published online at <https://osf.io/tbdr8/>

Declarations of competing interests

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2021.113685>.

References

Andrzejewski, J., Liddon, N., Leonard, S., 2018. Condom availability programs in schools: a review of the literature. *Am. J. Health Promot.* 890117118791118 <https://doi.org/10.1177/0890117118791118>.

- Arai, L., 2009. Teenage Pregnancy: the Making and Unmaking of a Problem, Teenage Pregnancy: the Making and Unmaking of a Problem. The Policy Press. <https://doi.org/10.1080/14681811.2011.609056>.
- Billingsley, M., 2011. Cuts threaten to undermine progress in reducing teenage pregnancies, charities claim. *BMJ* 342. <https://doi.org/10.1136/bmj.d1264> d1264–d1264.
- Blackman, T., 2013. Exploring explanations for local reductions in teenage pregnancy rates in England: an approach using qualitative comparative analysis. *Soc. Pol. Soc.* 12, 61–72. <https://doi.org/10.1017/S1474746412000358>.
- Bradley, T., Cupples, M.E., Irvine, H., 2002. A case control study of a deprivation triangle: teenage motherhood, poor educational achievement and unemployment. *Int. J. Adolesc. Med. Health* 14, 117–123. <https://doi.org/10.1515/IJAMH.2002.14.2.117>.
- Carabine, J., 2007. New labour's teenage pregnancy policy: constituting knowing responsible citizens? *Cult. Stud.* 21, 952–973. <https://doi.org/10.1080/09502380701470635>.
- Chang, W., Cheng, J., Allaire, J.J., Xie, Y., McPherson, J., 2019. Shiny: Web Application Framework for R.
- Cherry, A.L., Dillon, M.E., 2014. International handbook of adolescent pregnancy: medical, psychosocial, and public health responses. In: *International Handbook of Adolescent Pregnancy: Medical, Psychosocial, and Public Health Responses*. Springer US. <https://doi.org/10.1007/978-1-4899-8026-7>.
- Craig, P., Dundas, R., Leyland, A., Popham, F., 2016a. How successful was the English teenage pregnancy strategy? *Lancet* 388, 2604. [https://doi.org/10.1016/S0140-6736\(16\)32223-1](https://doi.org/10.1016/S0140-6736(16)32223-1).
- Craig, P., Katikireddi, S.V., Leyland, A., Popham, F., 2017. Natural experiments: an overview of methods, approaches, and contributions to public health intervention research. *Annu. Rev. Publ. Health* 38, 39–56. <https://doi.org/10.1146/annurev-publhealth-031816-044327>.
- Craig, P., Leyland, A., Dundas, R., Popham, F., 2016b. Reply to Wellings [unpublished manuscript]. *Lancet*. <https://osf.io/27c3r/>.
- Euro-Peristat, 2018. Country teams - euro-peristat [WWW Document]. URL. <https://www.europeristat.com/index.php/our-network/country-teams.html>, 4.3.19.
- Falk, G., Östlund, I., Magnuson, A., Schollin, J., Nilsson, K., 2006. Teenage mothers - a high-risk group for new unintended pregnancies. *Contraception* 74, 471–475. <https://doi.org/10.1016/j.contraception.2006.07.014>.
- Foster, H.W., 1997. The national campaign to prevent teen pregnancy. *J. Pediatr. Nurs.* 12, 120–121. [https://doi.org/10.1016/s0882-5963\(97\)80032-2](https://doi.org/10.1016/s0882-5963(97)80032-2).
- Furedi, A., 1999. The public health implications of the 1995 “pill scare”. *Hum. Reprod. Update* 5 (6), 621–626. <https://doi.org/10.1093/humupd/5.6.621>.
- Geronimus, A.T., 1997. Teenage childbearing and personal responsibility: an alternative view. *Polit. Sci. Q.* 112, 405–430. <https://doi.org/10.2307/2657564>.
- Girma, S., Paton, D., 2015. Is education the best contraception: the case of teenage pregnancy in England? *Soc. Sci. Med.* 131, 1–9. <https://doi.org/10.1016/j.socscimed.2015.02.040>.
- Guldi, M., Herbst, C.M., 2017. Offline effects of online connecting: the impact of broadband diffusion on teen fertility decisions. *J. Popul. Econ.* 30, 69–91. <https://doi.org/10.1007/s00148-016-0605-0>.
- Hadley, A., Chandra-Mouli, V., Ingham, R., 2016a. Implementing the United Kingdom government's 10-year teenage pregnancy strategy for England (1999–2010): applicable lessons for other countries. *J. Adolesc. Health* 59, 68–74. <https://doi.org/10.1016/j.jadohealth.2016.03.023>.
- Hadley, A., Ingham, R., Chandra-Mouli, V., 2016b. Implementing the United Kingdom's ten-year teenage pregnancy strategy for England (1999–2010): how was this done and what did it achieve? *Reprod. Health* 13, 139. <https://doi.org/10.1186/s12978-016-0255-4>.
- Heap, K.L., Berrington, A., Ingham, R., 2020. Understanding the decline in under-18 conception rates throughout England's local authorities between 1998 and 2017. *Health Place* 66, 1353–8292. <https://doi.org/10.1016/j.healthplace.2020.102467>.
- Henderson, M., Wight, D., Raab, G.M., Abraham, C., Parkes, A., Scott, S., Hart, G., 2007. Impact of a theoretically based sex education programme (SHARE) delivered by teachers on NHS registered conceptions and terminations: final results of cluster randomised trial. *BMJ* 334, 133. <https://doi.org/10.1136/bmj.39014.503692.55>.
- Hodgkinson, S., Beers, L., Southammakosane, C., Lewin, A., 2014. Addressing the mental health needs of pregnant and parenting adolescents. *Pediatrics* 133, 114–122. <https://doi.org/10.1542/peds.2013-0927>.
- Hoffman, S.D., 1998. Teenage childbearing is not so bad after all... Or is it? A review of the new literature. *Fam. Plann. Perspect.* 30, 236–239.
- Information Services Division Scotland, 2018a. Teenage Pregnancy: Year of Conception Ending 31 December 2016.
- Information Services Division Scotland, 2018b. Termination of Pregnancy - Year Ending December 2017.
- Irvine, H., Bradley, T., Cupples, M., Boohan, M., 1997. The implications of teenage pregnancy and motherhood for primary health care: unresolved issues. *Br. J. Gen. Pract.* 47, 323–326.
- Kearney, M.S., Levine, P.B., 2015. Investigating recent trends in the U.S. teen birth rate. *J. Health Econ.* 41, 15–29. <https://doi.org/10.1016/j.jhealeco.2015.01.003>.
- Kontopantelis, E., Doran, T., Springate, D.A., Buchan, I., Reeves, D., 2015. Regression based quasi-experimental approach when randomisation is not an option: interrupted time series analysis. *BMJ* 350. <https://doi.org/10.1136/bmj.h2750>.
- Kost, K., Maddow-Zimet, I., Arpaia, A., 2017. Pregnancies, Births and Abortions Among Adolescents and Young Women in the United States, 2013: National and State Trends by Age, Race and Ethnicity (New York).
- Lawlor, D.A., Shaw, M., 2002. Too much too young? Teenage pregnancy is not a public health problem. *Int. J. Epidemiol.* 31, 552–554. <https://doi.org/10.1093/ije/31.3.552>.

- Lawlor, D.A., Shaw, M., Johns, S., 2001. Teenage pregnancy is not a public health problem. *BMJ* 323, 1428–1429. <https://doi.org/10.1136/BMJ.323.7326.1428>.
- Letourneau, N.L., Stewart, M.J., Barnfather, A.K., 2004. Adolescent mothers: support needs, resources, and support-education interventions. *J. Adolesc. Health* 35 (6), 509–525. [https://doi.org/10.1016/S1054-139X\(04\)00069-2](https://doi.org/10.1016/S1054-139X(04)00069-2).
- Lopez Bernal, J., Cummins, S., Gasparrini, A., 2018. The use of controls in interrupted time series studies of public health interventions. *Int. J. Epidemiol.* 47 (6), 2082–2093. <https://doi.org/10.1093/ije/dyy135>.
- Lopez Bernal, J., Cummins, S., Gasparrini, A., 2017. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int. J. Epidemiol.* 46 (1), 348–355. <https://doi.org/10.1093/ije/dyw098>.
- Ma, R., 2016. England's teenage pregnancy strategy has been a success: now let's work on the rest. *Lancet* 388, 1981. [https://doi.org/10.1016/S0140-6736\(16\)31856-6](https://doi.org/10.1016/S0140-6736(16)31856-6).
- Marseille, E., Mirzazadeh, A., Biggs, M.A., P. Miller, A., Horvath, H., Lightfoot, M., Malekinejad, M., Kahn, J.G., 2018. Effectiveness of school-based teen pregnancy prevention programs in the USA: a systematic review and meta-analysis. *Prev. Sci.* 19, 468–489. <https://doi.org/10.1007/s11212-017-0861-6>.
- Max Planck Institute for Demographic Research, 2019. Human fertility Database [WWW Document]. URL <https://www.humanfertility.org/cgi-bin/main.php>, 3.25.19.
- National Records of Scotland, 2018. Births time series data [WWW Document]. URL <https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/births/births-time-series-data>, 4.3.19.
- NHS Digital, 2019. Smoking, Drinking and Drug Use Among Young People in England 2018.
- NHS Health Scotland, 2014. Evaluation of healthy Respect phase 2 [WWW Document]. URL http://www.healthscotland.com/scotlands-health/evaluation/programme/evaluation-respect-2.aspx#Phase_2, 10.24.17.
- Office for National Statistics, 2019. Conceptions in England and Wales: 2017 [WWW Document]. URL <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandfertilityrates/bulletins/conceptionstatistics/2017>, 4.23.19.
- Office for National Statistics, 2017. Conception statistics QMI [WWW Document]. URL <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandfertilityrates/methodologies/conceptionstatisticsqmi>, 1.5.18.
- Organisation for Economic Co-operation and Development, 2018. Education resources - public spending on education - OECD Data [WWW Document]. URL <https://data.oecd.org/eduresource/public-spending-on-education.htm>, 10.21.19.
- Paton, D., Bullivant, S., Soto, J., 2020. The impact of sex education mandates on teenage pregnancy: international evidence. *Health Econ.* 29, 790–807. <https://doi.org/10.1002/hec.4021>.
- Paton, D., Wright, L., 2017. The effect of spending cuts on teen pregnancy. *J. Health Econ.* 54, 135–146. <https://doi.org/10.1016/j.jhealeco.2017.05.002>.
- Penfold, R.B., Zhang, F., 2013. Use of interrupted time series analysis in evaluating health care quality improvements. *Acad. Pediatr.* 13 <https://doi.org/10.1016/j.acap.2013.08.002>.
- Public Health England, Local Government Association, 2018. Teenage Pregnancy Prevention Framework: Supporting Young People to Prevent Unplanned Pregnancy and Develop Healthy Relationships.
- R Core Team, 2020. R: A Language and Environment for Statistical Computing.
- RStudio Team, 2015. RStudio: Integrated Development Environment for R.
- Scottish Executive, 2005. Respect and Responsibility Strategy and Action Plan for Improving Sexual Health (Edinburgh).
- Scottish Executive, 2003. Enhancing Sexual Wellbeing in Scotland A Sexual Health and Relationships Strategy (Edinburgh).
- Sedgh, G., Finer, L.B., Bankole, A., Eilers, M.A., Singh, S., 2015. Adolescent pregnancy, birth, and abortion rates across countries: levels and recent trends. *J. Adolesc. Health* 56, 223–230. <https://doi.org/10.1016/j.jadohealth.2014.09.007>.
- Sipsma, H.L., Canavan, M., Gilliam, M., Bradley, E., 2017. Impact of social service and public health spending on teenage birth rates across the USA: an ecological study. *BMJ Open* 7, e013601. <https://doi.org/10.1136/bmjopen-2016-013601>.
- Skinner, S.R., Marino, J.L., 2016. England's teenage pregnancy strategy: a hard-won success. *Lancet* 388, 538–540. [https://doi.org/10.1016/S0140-6736\(16\)30589-X](https://doi.org/10.1016/S0140-6736(16)30589-X).
- Social Exclusion Unit, 1999. Teenage Pregnancy: Report by the Social Exclusion Unit Presented to Parliament by the Prime Minister by Command of Her Majesty, June 1999. Social Exclusion Unit.
- Statistics New Zealand, 2019a. Live births by age of mother (Annual-Dec) - table reference VSB004AA [WWW Document]. URL <http://stats.govt.nz>, 2.19.19.
- Statistics New Zealand, 2019b. Abortions by age of mother (Annual-Dec) - table reference ABN005AA [WWW Document]. URL <http://stats.govt.nz>, 2.19.19.
- Swann, C., Bowe, K., McCormick, G., Kosmin, M., 2003. Teenage Pregnancy and Parenthood: A Review of Reviews. Evidence Briefing, vol. 62. London Heal. Dev. Agency.
- Teenage Pregnancy Strategy Evaluation, 2005. Final Report. Synthesis.
- The Family Planning Association, 2015. Teenage Pregnancy - Northern Ireland Factsheet - FPA.
- The World Bank Group, 2019. World Bank open data | data [WWW Document]. URL <https://data.worldbank.org/>, 4.23.19.
- Trivedi, D., Bunn, F., Graham, M., Wentz, R., 2007. Update on review of reviews on teenage pregnancy and parenthood. Submitted as an Addendum to the first evidence briefing 2003. *Natl. Inst. Heal. Clin. Excell.* 76.
- Twenge, J.M., 2017. Have smartphones destroyed a generation? [WWW Document]. *Atl.* URL <https://www.theatlantic.com/magazine/archive/2017/09/has-the-smartphone-destroyed-a-generation/534198/>, 11.1.19.
- UNESCO Education Sector, 2017. Early and Unintended Pregnancy & the Education Sector - Evidence Review and Recommendations (Paris).
- University of California, Max Plank Institute of Demographic Research, 2019. The human mortality Database [WWW Document]. URL <https://www.mortality.org/>, 4.9.19.
- Wellings, K., Jones, K.G., Mercer, C.H., Tanton, C., Clifton, S., Datta, J., Copas, A.J., Erens, B., Gibson, L.J., Macdowall, W., Sonnenberg, P., Phelps, A., Johnson, A.M., 2013. The prevalence of unplanned pregnancy and associated factors in Britain: findings from the third national survey of sexual attitudes and lifestyles (Natsal-3). *Lancet* 382, 1807–1816. [https://doi.org/10.1016/S0140-6736\(13\)62071-1](https://doi.org/10.1016/S0140-6736(13)62071-1).
- Wellings, K., Palmer, M.J., Geary, R.S., Gibson, L.J., Copas, A., Datta, J., Glasier, A., Scott, R.H., Mercer, C.H., Erens, B., Macdowall, W., French, R.S., Jones, K., Johnson, A.M., Tanton, C., Wilkinson, P., 2016. Changes in conceptions in women younger than 18 years and the circumstances of young mothers in England in 2000–12: an observational study. *Lancet* 388, 586–595. [https://doi.org/10.1016/S0140-6736\(16\)30449-4](https://doi.org/10.1016/S0140-6736(16)30449-4).
- WHO Regional Office for Europe, 2019. Health for all explorer - European health information gateway [WWW Document]. URL <https://gateway.euro.who.int/en/hfa-explorer/>, 9.9.19.
- Wilkinson, P., French, R., Kane, R., Lachowycz, K., Stephenson, J., Grundy, C., Jacklin, P., Kingori, P., Stevens, M., Wellings, K., 2006. Teenage conceptions, abortions, and births in England, 1994–2003, and the national teenage pregnancy strategy. *Lancet* 368, 1879–1886. [https://doi.org/10.1016/S0140-6736\(06\)69777-8](https://doi.org/10.1016/S0140-6736(06)69777-8).
- World Health Organization, 2020. Adolescent pregnancy [WWW Document]. URL <https://www.who.int/news-room/fact-sheets/detail/adolescent-pregnancy>, 12.3.20.
- Zhang, F., Wagner, A.K., Ross-Degnan, D., 2011. Simulation-based power calculation for designing interrupted time series analyses of health policy interventions. *J. Clin. Epidemiol.* 64, 1252–1261. <https://doi.org/10.1016/j.jclinepi.2011.02.007>.